EE 481/581 Microwave Engineering
Quiz #4 (Fall 2024)

Name KEY A

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (60 Ω, 2.4×10^8 m/s) has a load with a measured reflection coefficient of $0.52\angle 100.5°$ at 600 MHz. Calculate the wavelength (cm). Then, using a Smith chart, find the load impedance and standing wave ratio (SWR). Finally, design a single series capacitor matching network (distance d and C) with the capacitor positioned as close as possible to the load. Sketch in box provided with all relevant quantities. **Show** and **clearly label** all work on the Smith chart (this will be graded).

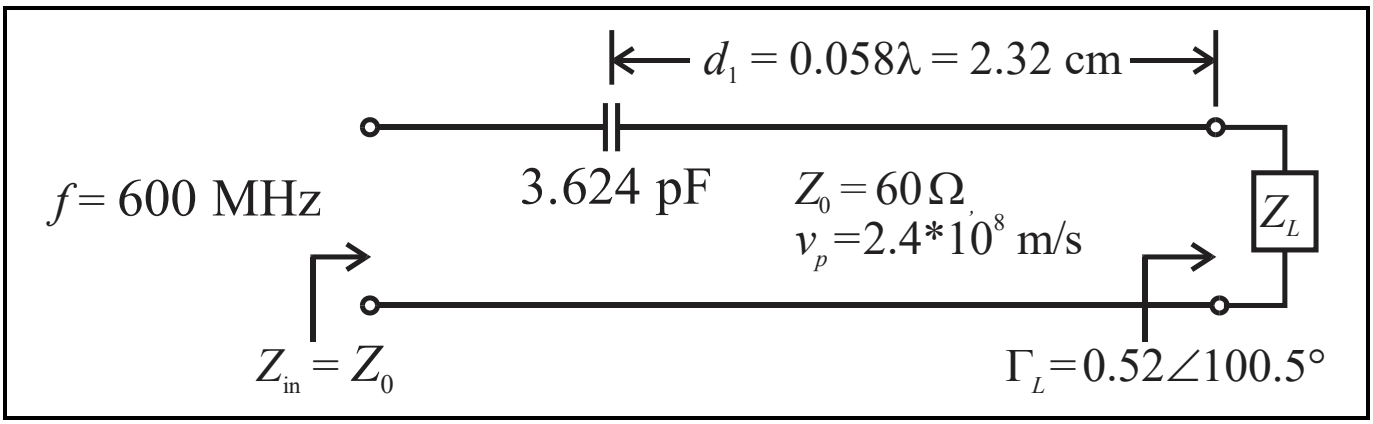
- Wavelength $\lambda = v_p/f = 2.4\times10^8/600\times10^6 \Rightarrow$ **$\lambda = 0.4$ m = 40 cm**.

Steps

1) Plot $\Gamma_L = 0.52\angle 100.5°$ on Smith chart.
2) Read $z_L = 0.5 + j\,0.7$ Ω/Ω. Compute $Z_L = Z_0\, z_L = 60\,(0.5 + j\,0.7) \Rightarrow$ **$Z_L = 30 + j\,42$ Ω**.
3) Draw circle, centered on Smith chart, through Γ_L/z_L point and arc on SWR scale. Read SWR = 3.17.
4) The two points are $z_{m,i} = 1 \pm j1.22$ Ω/Ω. Choose $z_{m,1} = 1 + j1.22$ Ω/Ω (inductive x).
5) Find the distance d_1 from z_L to $z_{m,1}$ using the "WAVELENGTHS TOWARD GENERATOR" scale as $d_1 = (0.1681\text{-}0.1101)\lambda \Rightarrow$ **$d_1 = 0.058\,\lambda = 2.32$ cm**.
6) At $z_{m,1}$ add a series capacitor with reactance $Z_{cap} = -j1.22(60) = -j73.2\ \Omega = -j/\omega C$. Solving for $C = 1/(2\pi\, 600\times10^6\, 73.2) \Rightarrow$ **$C = 3.624$ pF**.

wavelength = **$\lambda = 0.4$ m = 40 cm** Z_L = **$30 + j\,42$ Ω** SWR = **3.17**

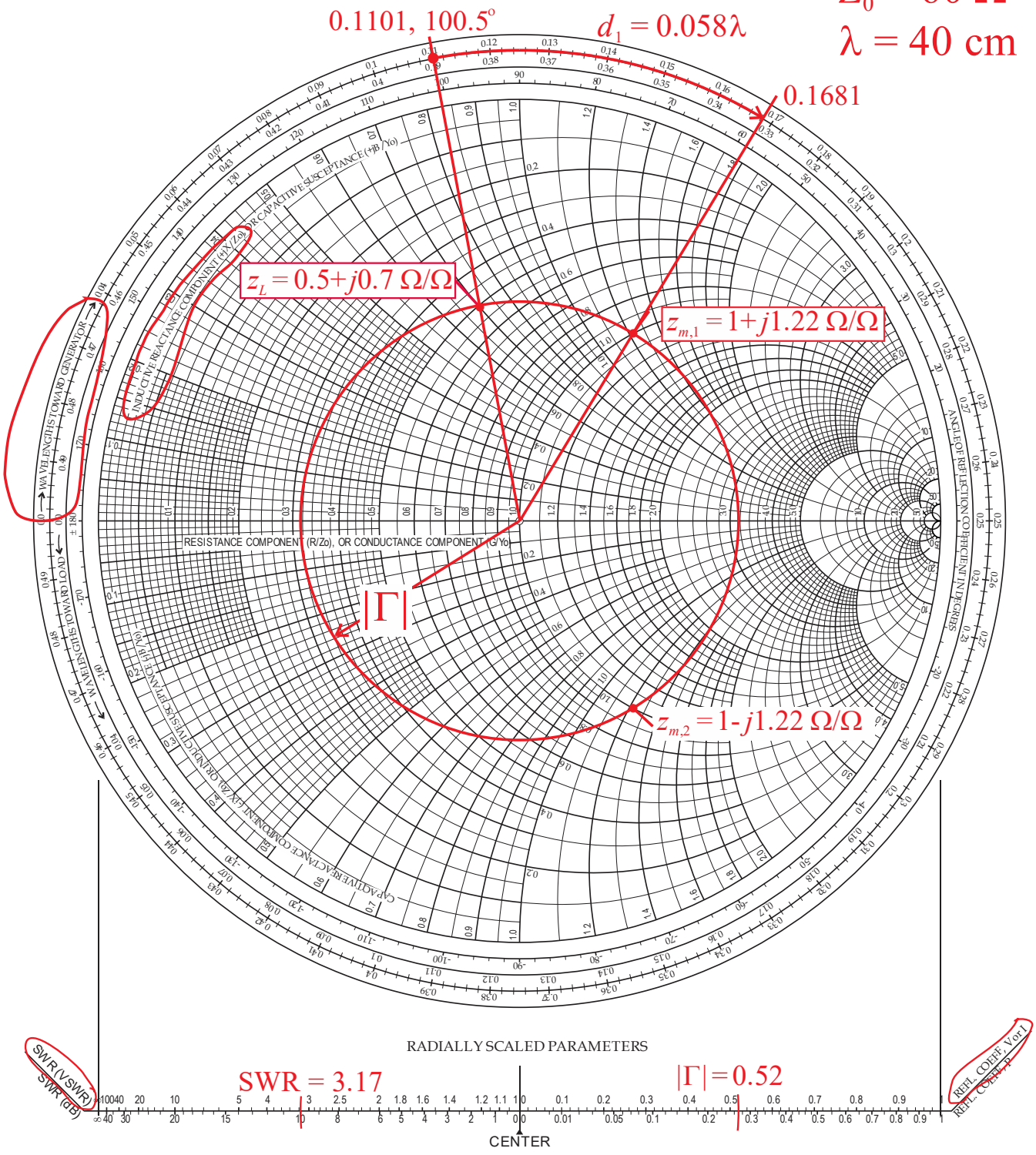
d = **$d_1 = 0.058\,\lambda = 2.32$ cm** C = **3.624 pF**



Simple Smith Chart

$Z_0 = 60\ \Omega$

$\lambda = 40$ cm



EE 481/581 Microwave Engineering
Quiz #4 (Fall 2024)

Name KEY B

Instructions: Open book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (80 Ω, 2.4×10^8 m/s) has a load with a measured reflection coefficient of $0.382\angle -111.3°$ at 800 MHz. Calculate the wavelength (cm). Then, using a Smith chart, find the load impedance and standing wave ratio (SWR). Finally, design a single series capacitor matching network (distance d and C) with the capacitor positioned as close as possible to the load. Sketch in box provided with all relevant quantities. **Show** and **clearly label** all work on the Smith chart (this will be graded).

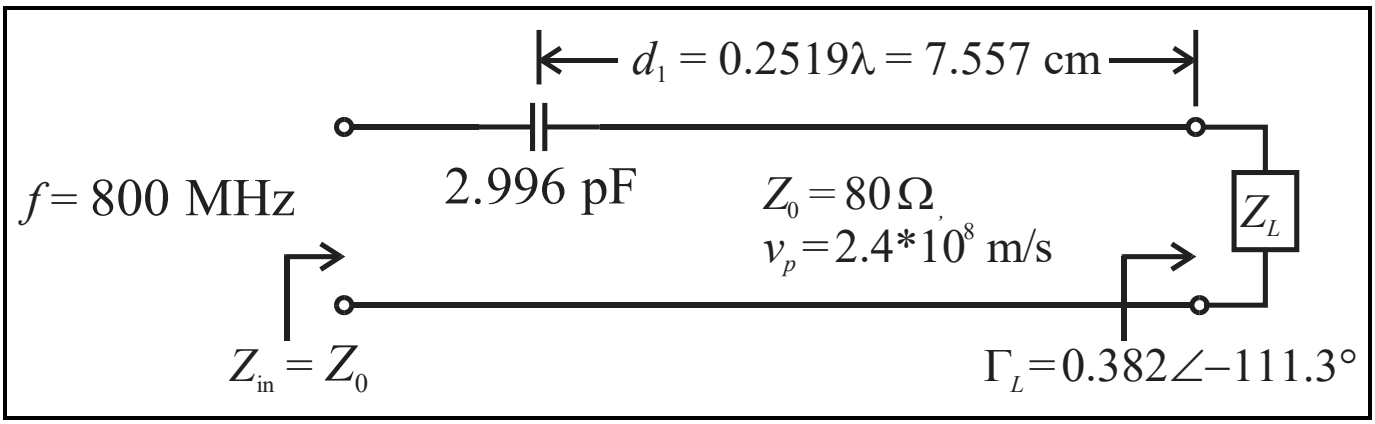
- Wavelength $\lambda = v_p/f = 2.4\times10^8/800\times10^6 \Rightarrow$ **$\lambda = 0.3$ m = 30 cm**.

Steps

1) Plot $\Gamma_L = 0.382\angle -111.3°$ on Smith chart.
2) Read $z_L = 0.6 - j\,0.5$ Ω/Ω. Compute $Z_L = Z_0\, z_L = 80\,(0.6 - j\,0.5) \Rightarrow$ **$Z_L = 48 - j\,40$ Ω**.
3) Draw circle, centered on Smith chart, through Γ_L/z_L point and arc on SWR scale. Read SWR = 2.24.
4) The two points are $z_{m,i} = 1 \pm j0.83$ Ω/Ω. Choose $z_{m,1} = 1 + j0.83$ Ω/Ω (inductive x).
5) Find the distance d_1 from z_L to $z_{m,1}$ using the "WAVELENGTHS TOWARD GENERATOR" scale as $d_1 = (0.0958+0.1561)\lambda \Rightarrow$ **$d_1 = 0.2519\,\lambda = 7.557$ cm**.
6) At $z_{m,1}$ add a series capacitor with reactance $Z_{cap} = -j0.83(80) = -j66.4$ Ω $= -j/\omega C$. Solving for $C = 1/(2\pi\, 800\times10^6\, 66.4) \Rightarrow$ **$C = 2.996$ pF**.

wavelength = **$\lambda = 0.3$ m = 30 cm** $Z_L =$ **$48 - j\,40$ Ω** SWR = **2.24**

$d =$ **$d_1 = 0.2519\,\lambda = 7.557$ cm** $C =$ **2.996 pF**



Simple Smith Chart

$Z_0 = 80\ \Omega$

$\lambda = 30$ cm